# Modern Concepts of Cardiovascular Disease

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## TRICHTERBRUST AND CARDIAC DISEASE

Association of cardiac symptoms with depression of the sternum known as "Trichterbrust" or "Funnel Chest" has attracted occasional interest, but has failed to promote standard methods of treatment. Rather is it true that medical opinions are widely at variance as to the significance of the condition in relationship to cardiac symptoms and the types of therapy which may be employed. The condition is usually a congenital anomaly. It may also occur as the result of disease in early life or subsequent to trauma. It may appear as a developmental defect associated with other phenomena of perverted growth. Some authors have reported a familial tendency to the disease.

Little attention was paid to the subject prior to the appearance of Ebstein's paper in 1882. This report included five cases, which the author coordinated as a single disease picture. Ebstein used the word "Trichterbrust" to describe the clinical entity. A few well-defined cases had been reported previously. In 1860 an anonymous communication appeared in the Gaz. des Hop. In the same year, Woillez reported a case: this report probably concerned a medical student whom Rokitansky had examined and discussed in 1857: the patient was making the rounds of the medical school about that time. In the "Transactions of the Pathological Society of London" for 1872, Williams described "a lad of 17" who, "was borne with this hollow in his chest." A case was described by Flesch in 1873. The sagittal distance between the spine and thorax was estimated at 4.4 c.m. "Respiratory pains have never been present; the patient can even do hard work without dyspnoea."

As to the anatomical characteristics of Trichterbrust, Wolostnich says there is practical agreement: "The upper limit of Trichterbrust is formed by the connecting line between the manubrium and corpus sterni: from this situation the funnel-shaped depression runs downward and backward; in most instances the greatest depth is reached at the Scrobiculus cordis. The rounded base has a very slight extension, the diameter of which is variable. From the base of this depression its wall runs forward in such a manner, corresponding to its funnel shape, that on the anterior wall of the body the maximum breadth varies between 9 and 17.2 c.m. The center of the depression is not always in the middle of the sternum and the line of depth of the furrow is not always straight. This circular or oval depression at the lower end of the sternum may reach a depth of 6 or 7 centimeters."

As a result of this deformity, various degrees of cardiac displacement have been reported. Versé studied the thorax of a female subject who died at the age of 48 years. The thorax was removed in toto and hardened for two days. The lower end of the corpus sterni bounded the deepest part of the depression and almost touched the spine at the level of the cartilage between the tenth and eleventh thoracic vertebrae. Here the distance from bone to bone measured only about 1 c.m. The thin cartilaginous processus xiphoides was 4 c.m. long and directed obliquely forward: its tip was distant from the spine 3.7 c.m. The chief mass of the heart was to the left of the mid-line. Almost the entire left ventricle and a small part of the left auricle with the largest part of the mitral valve were lateral to the left parasternal line. Von Bien reported an autopsy at which the heart was found to lie "entirely in the left half of the thorax, while the right half was filled by the lungs." Von Pohl described the thoracic deformity as producing "an indentation of the heart in front, corresponding to the in-bowing of the anterior thoracic wall, and the antero-posterior diameter is diminished."

Clinically, cardiac displacement has been noted frequently. This has been more accurately demonstrated since the era of Roentgenology. Von Rösler, discussing the results of examination by the X-ray in cases of thoracic deformity, remarked regarding Trichterbrust: "It is plausible that in high-grade cases, the cardiac work is unfavorably influenced through the flattening of the heart; the normal systolic-diastolic change of form and rotation must be made difficult; the circulatory relations of the blood in the heart itself, probably also the position and form of the venous openings, may be changed."

In spite of the marked deformity, the changes in the dimensions of the space normally occupied by the heart and the anatomical evidence of change in the position and even of the shape of the heart, there is no agreement as to the effect of the deformity upon cardiac function. Von Eggel's patient in whom the distance from the deepest part of the sternum to the corresponding vertebral spine was only 11 c.m. (according to Vierordt the normal distance from the ensiform to the thoracic spine is 15 to 19 c.m.), "could not lift such heavy burdens nor run as fast as others of like occupation, but without distress he carried on his work as an efficient farmer, walked with firm tread and showed no trace of dyspnoea, to say nothing of cyanosis. When he was six years old his physician had predicted that he would not outlive his twentieth year. Within four weeks of his birth the breast was so

## SCIENTIFIC MEETINGS

**The Fourteenth Scientific Meetings of the American Heart Association will be held in the Empire Room, Sir Francis Drake Hotel, San Francisco, California, June 10 and 11, 1938. The general cardiac program will be given on Friday, June 10, and the program of the Section for the Study of the Peripheral Circulation on Saturday, June 11.**

sunken that an egg could have been laid in the furrow." In 1911 Groedel reported three well established cases. It was his opinion that satisfactory evidence was not at hand to warrant the assertion that this deformity is responsible for cardiac failure. He contends that while Trichterbrust does change the form and shape of the thorax, it does not change the content. The lung accommodates itself to displacement as does the heart, without necessarily involving these organs in functional damage. Groedel also pointed out the frequent association of Trichterbrust with the habitus asthenicus. In the latter condition symptoms of circulatory embarrassment similar to those described as the result of displacement from the depressed sternum are found. In one of our own cases, we were doubtful as to the relationship of improvement to the operation: the patient was so obviously of the neurasthenic type that apparent improvement may have been due largely to the fact that she had undergone an operation. The extent of associated stigmata of the habitus asthenicus calls for careful consideration as to the degree of permanent relief which may be expected from surgical treatment of the deformity.

Wolostnich maintains that "The function of the heart and the pulmonary capacity commonly remain normal. The affected individuals have no pains from their Trichterbrust and very often—as is definitely stated in many papers—the whole deformity presents an accidental and incidental finding upon the examination of a patient who has sought the physician for other reasons." Edeiken and Wolferth reported a study of ten cases of moderate or severe funnel chest in order to determine the effect upon the heart. They believe that "uncomplicated funnel chest does not appear to have any clearly defined effect upon the functional capacity of the heart unless the deformity is traumatic or of rapid development. The lack of symptoms is probably explained by the slow development in the vast majority of cases. This allows for accommodation within the chest and heart."

On the other hand, the opinion that this deformity may, and occasionally does, impair the cardiac function is expressed by various authors. Lommel states that congenital Trichterbrust exerts a significant effect upon the development of the circulatory organs and through displacement or pressure may produce an effect upon particular portions of the heart as well as the aorta and its branches. Schaefer, after a review of cases says, "The heart of the patient with Trichterbrust like that of the kyphoscoliotic heart will often become insufficient early and lead to illness, invalidism and death. This fact demands the serious attention of the physician: not so much in the frank cases of cardiac decompensation as in the milder cases with beginning auscultatory symptoms."

In 1911, Ludwig Meyer performed the first operation for the relief of circulatory symptoms in Trichterbrust. Sauerbruch reported a successful operation upon a young man of 18, whose symptoms were cardiac irregularity and dyspnoea upon exertion. Three years later the patient had gained weight, felt well and was working twelve to fourteen hours a day. Von Hoffmeister reported the case of a young man of 19, who, for two years, had complained of cardiac pain, dyspnoea upon exertion and palpitation. Twelve weeks after operation the general condition was essentially improved, there was a gain in weight and dyspnoea was present only to a slight degree. Zahradnicek reported a case with a satisfactory result: the patient, a boy of 16, had a high degree of funnel-shaped breast, and was dyspneic and troubled by palpitation. Alexander has reported two cases of traumatic depression of the sternum, both of which resulted successfully. One patient had dyspnoea and occasional dysphagia; the other, dyspnoea and palpitation: both patients were completely relieved. Truesdall and Hyatt believe that the advanced form of Trichterbrust causes a permanent shift of the heart and respiratory tree and is often a restraint upon the vital capacity of the young adult. They report four cases, two of which were operated. One patient with an associated diaphragmatic hernia died. The other recovered and was discharged from the hospital two months after operation: at that time he was free of cardiac embarrassment.

Three patients with Trichterbrust have been under our observation. One, a young woman of 19, unmarried, had been subject to fainting spells for two years. She was a thin, sickly young woman, pale and with moderate cyanosis of the lips, who had been told that she had a mitral lesion, and later, by another physician, was treated for tuberculosis. Operation was performed by Dr. Jerome Head: on the left side the 3rd, 4th, 5th, 6th and 7th costal cartilages were removed, and on the right side, the 4th, 5th, 6th and 7th. The lower one-half of the sternum together with the xiphoid was resected. Four weeks after discharge from the hospital the patient reported that she had lost her cardiac consciousness and was walking a mile or more daily. After another three months, continued improvement was reported. Within a year, however, she reported that she was nervous and had lost some weight. An unhappy domestic situation had provoked these symptoms. However her last state was so much like her first that it suggested the possibility that the apparent improvement following the operation was psychic. Another patient, a boy of 13, was under our observation for some time. Largely because of a previous gastric hemorrhage for which we could not account, we did not urge operation. A third patient known to us, a man of about fifty, died following an operation. In this case, the electrocardiograms showed marked right ventricular preponderance. Doctor Marquardt has placed at my disposal the record of another successful case. A boy of 17 noticed distress in the region of the heart. Beginning with eructations, he would have attacks of pain over the heart: the pain was sharp and sticking. His ability to play baseball up to the past few months confused the diagnosis somewhat. He did not describe dyspnoea at any time: cardiac pain was his complaint. The electrocardiogram both before and after operation showed a definite right preponderance. The patient left the hospital in good condition and has been free of his symptoms over a period of three years.

## CONCLUSIONS

I. Trichterbrust or Funnel Chest may be the result of developmental, pathological or traumatic factors.

II. In occasional cases, this deformity may be responsible for cardiac symptoms although it is true that most of these patients sustain the deformity through long periods with surprisingly adequate cardiac function. In the presence of persistent and increasing evidence of cardiac embarrassment not based upon other disease, surgery should be considered.

III. In determining the indications for operative procedure three factors are of especial importance:
   (a) Care must be taken to evaluate the nervous symptoms which are so prominent in most cases.
   (b) The traumatic type appears to offer the best promise of satisfactory results following operation.
   (c) Surgery should be undertaken only after careful appraisal of the indications and with due regard to the magnitude of the operation.

IV. Final evaluation of the operation must be postponed for some time.

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